



Problems with Imaging of Wide- Incidence-Angle Reflections in Crosswell Data

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Potential Problems with Wide-Angle Reflections

- ❖ ***Incidence Angle beyond the Critical Angle***
- ❖ ***Fresnel Zone Smearing***
- ❖ ***Imaging Stretch after VSP-CDP Mapping***

Modeling Methodology

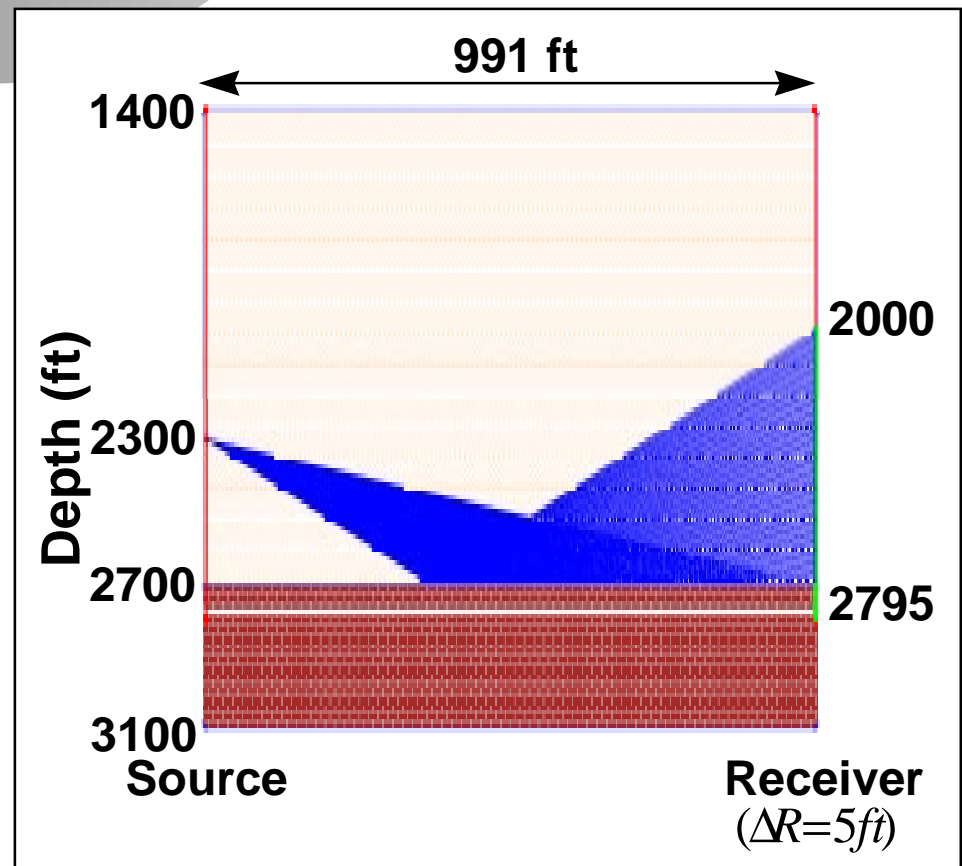
Elastic Ray Tracing

- ❖ ***No Fresnel zone effect***
- ❖ ***Correctly deals with post-critical effect***

Acoustic Wave Equation

- ❖ ***Incorporates Fresnel zone effect***
- ❖ ***Does not handle post-critical incidence angle correctly***

Model Geometry for Post-Critical Incidence Angle & Stretch



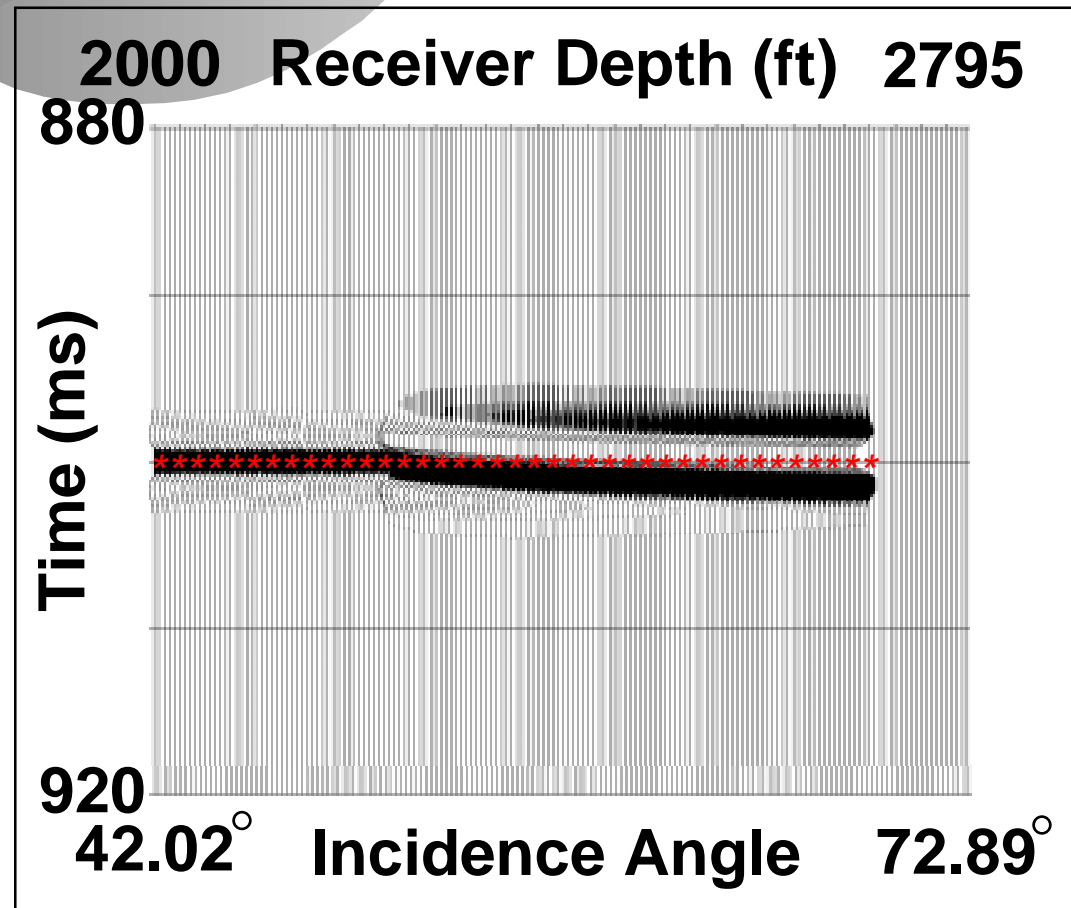
Post-critical Incidence Angle

$$\theta_c = 48.59^\circ$$

***Rearrange the
reflected waves at
the same time
level***

Velocity $\frac{6000 \text{ ft} / \text{s}}{8000 \text{ ft} / \text{s}}$

***** : Ray Theoretical
Reflection Time**



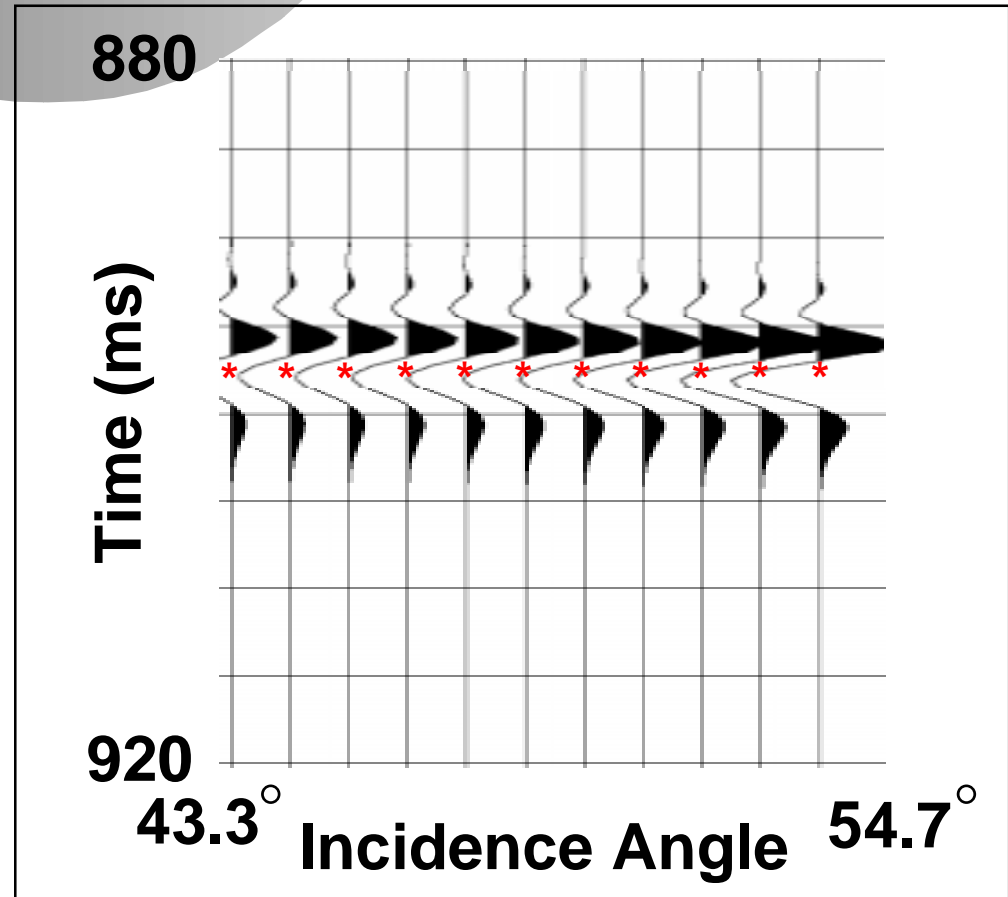
Fresnel Zone Effect

AVA Gather

***Rearrange the
reflected waves at
the same time
level***

Velocity $\frac{6000 \text{ ft} / \text{s}}{5900 \text{ ft} / \text{s}}$

****** : Ray Theoretical
Reflection Time***



Stretch after VSP-CDP Mapping

Ray Tracing

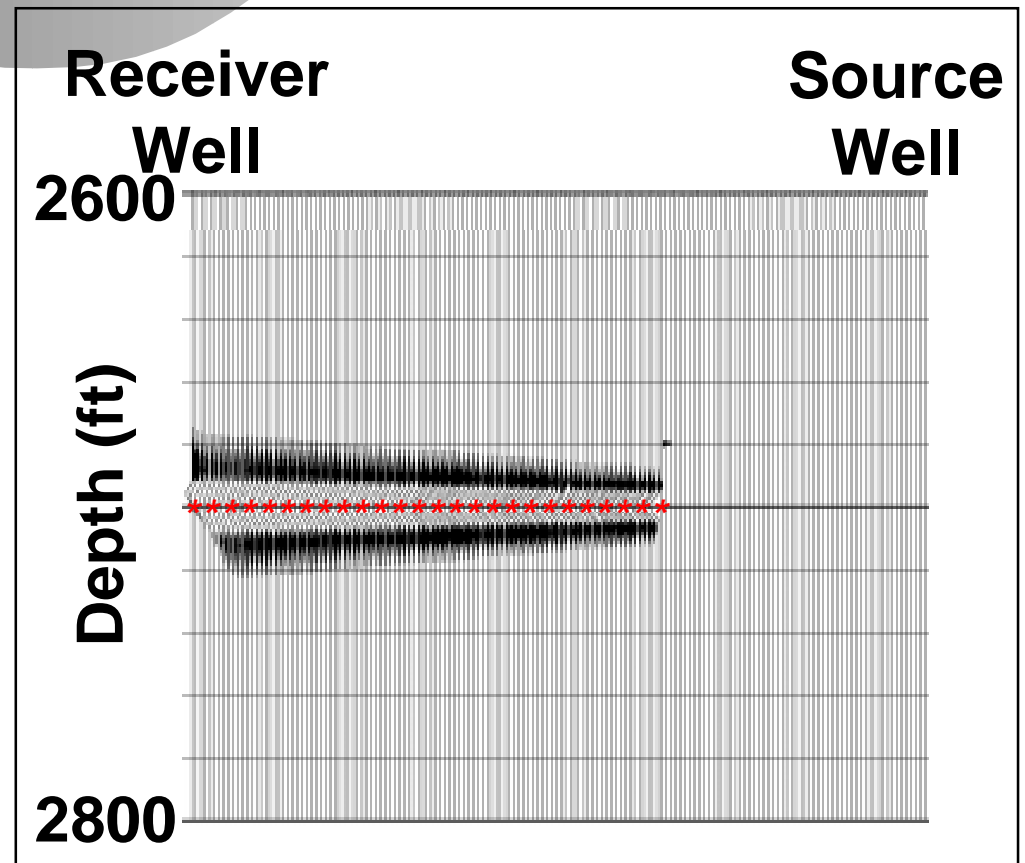
VSP-CDP Mapping

Velocity

$\frac{6000 \text{ ft} / s}{4000 \text{ ft} / s}$

No Critical Angle

****** : True Depth of the reflector***



Comparison of Phase Shift with Incidence Angle

Range of incidence angle: $50.91^\circ \sim 54.76^\circ$

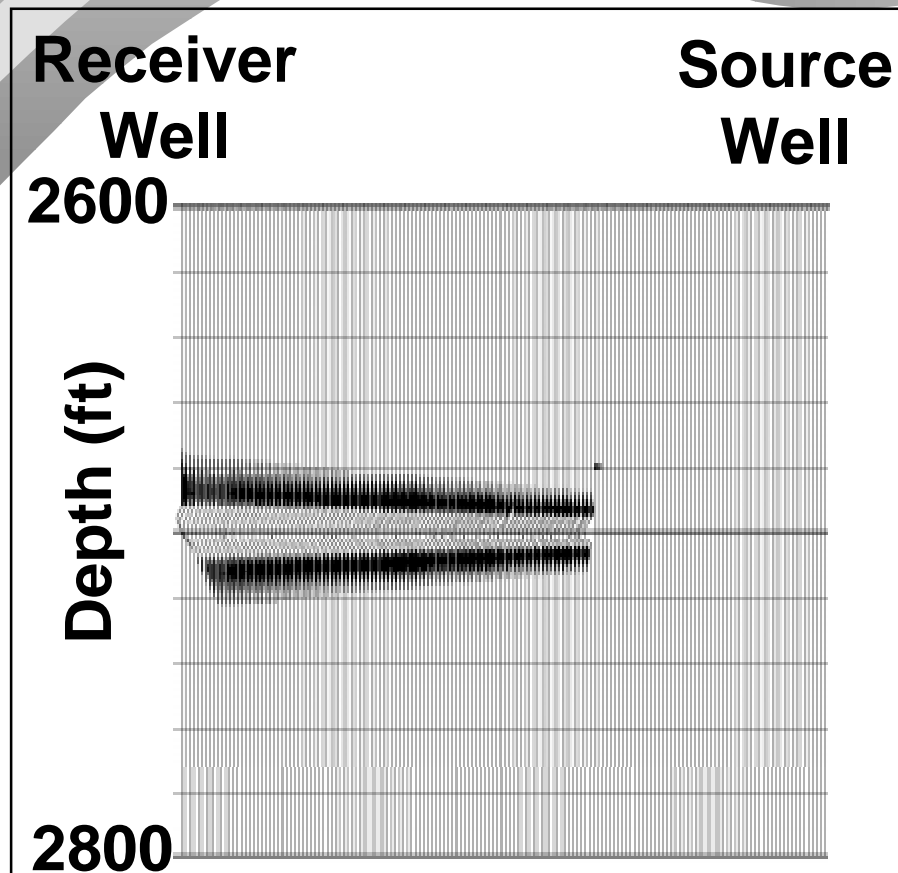
Measured Value: $\Delta t / \Delta \theta_i$

- ❖ ***Post-critical incidence angle: 0.10 ms***
- ❖ ***Fresnel zone: 0.05 ms***
- ❖ ***Stretch after VSP-CDP mapping: 0.69 ms***

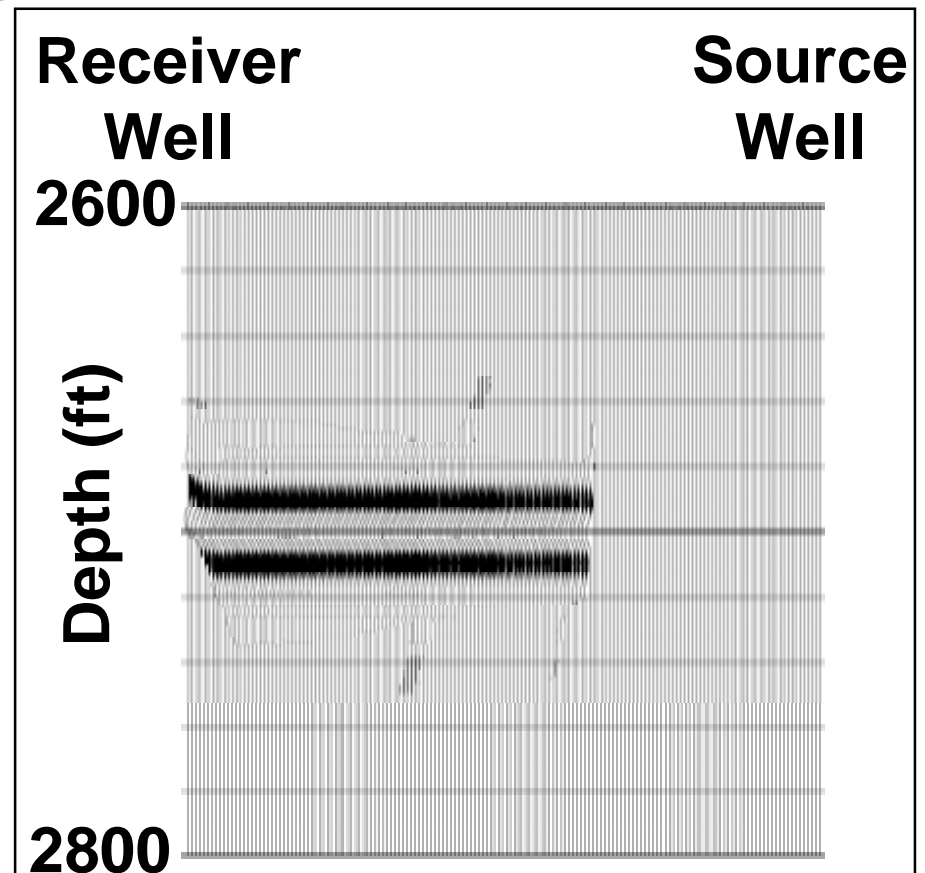
“ The vertical stretch effect after VSP-CDP mapping is the most severe. ”

Compensation for stretch effect in VSP-CDP mapping

Before Spectral Shaping



After Spectral Shaping



Conclusions & Future Work

- ❖ ***If the incidence angle is beyond the critical angle, a phase shift occurs in reflected wave.***
- ❖ ***The in-plane size of Fresnel zone increases with increasing incidence angle.***
- ❖ ***The vertical stretch effect after VSP-CDP mapping increases with increasing incidence angle.***
- ❖ ***Vertical stretch is the most severe effect.***
- ❖ ***Vertical stretch was corrected with spectral shaping method for a simple model.***
- ❖ ***Investigation of diffraction compensation with migration.***